CLAIMS

1. A method of fabricating a magnetoelectronic device, the method comprising the steps of:

depositing at least one magnetic region having an induced magnetic anisotropy with a resultant magnetic moment vector, a magnitude, and a direction, wherein the induced magnetic anisotropy is created by depositing at least a portion of the at least one magnetic region at a nonzero deposition angle relative to a reference line oriented perpendicular to a surface of the magnetoelectronic device.

2. A method as claimed in claim 1 including in addition the step of depositing the at least one magnetic region using one of an ion beam deposition system and a physical vapor deposition system with a sputtering target wherein a substrate is swept over the sputtering target.

3. A method as claimed in claim 1 wherein the at least one magnetic region includes an electrically insulating material layer sandwiched therebetween a first ferromagnetic layer and a second ferromagnetic layer and wherein the electrically insulating material layer forms a tunneling junction.

4. A method as claimed in claim 3 wherein the at least one magnetic region includes at least one layer of an anti-ferromagnetic coupling material.

5. A method as claimed in claim 4 wherein the portion of the at least one magnetic region deposited at the nonzero deposition angle is one of the first ferromagnetic layer, the second ferromagnetic layer, the electrically insulating material layer, the at least one layer of the anti-ferromagnetic coupling material, and combinations thereof.

6. A method as claimed in claim 1 wherein the at least one magnetic region is sandwiched therebetween a first conductive line and a second conductive line.

7. A method as claimed in claim 1 wherein the nonzero deposition angle is chosen so that the direction of the induced magnetic anisotropy is oriented substantially perpendicular to a deposition plane of incidence.

8. A method as claimed in claim 1 wherein the nonzero deposition angle is chosen so that the direction of the induced magnetic anisotropy is oriented substantially parallel to a deposition plane of incidence.

9. A method as claimed in claim 6 wherein the portion of the at least one magnetic region deposited at the nonzero deposition angle is a seed layer deposited adjacent to at least one of the first and second conductive lines.

10. A method as claimed in claim 9 wherein the subsequent layers deposited on the seed layer are deposited at a substantially zero deposition angle relative to the reference line.

11. A method as claimed in claim 1 wherein the nonzero deposition angle is chosen to supplement or oppose at least one of a shape anisotropy, a pair ordering anisotropy, and an intrinsic anisotropy of at least one of the first and second magnetic regions.

12. A method of fabricating a magnetoresistive tunneling junction device with a switching field, the method comprising the steps of:

providing a substrate with a surface;

depositing a first magnetic region having a resultant magnetic moment vector with a magnitude fixed in a preferred direction in the absence of an applied magnetic field onto the substrate wherein the first magnetic region has a thickness and a first induced magnetic anisotropy;

depositing an electrically insulating material onto the first magnetic region to form a magnetoresistive tunneling junction; and

depositing a second magnetic region onto the electrically insulating material, the second magnetic region having a second induced magnetic anisotropy and a resultant magnetic moment vector with a magnitude oriented in a position parallel or anti-parallel to the preferred direction of the first magnetic region wherein at least a portion of one of the first and second magnetic regions is deposited at a nonzero deposition angle relative to a reference line oriented substantially perpendicular to the surface of the substrate.

13. A method as claimed in claim 12 wherein at least one of the first and second magnetic regions include a synthetic anti-ferromagnetic material layer that has an adjustable magnetic switching volume wherein the synthetic anti-ferromagnetic layer material includes N ferromagnetic layers which are anti-ferromagnetically coupled, where N is a whole number greater than or equal to two.

14. A method as claimed in claim 12 wherein the nonzero deposition angle is chosen to obtain the switching field.

15. A method as claimed in claim 13 wherein each N ferromagnetic layer is anti-ferromagnetically coupled by sandwiching a layer of an anti-ferromagnetic coupling material between each adjacent ferromagnetic layer.

16. A method as claimed in claim 12 wherein the nonzero deposition angle is chosen so that at least one of the first and second induced magnetic anisotropies is oriented substantially perpendicular to a deposition plane of incidence.

17. A method as claimed in claim 12 wherein the nonzero deposition angle is chosen so that at least one of the first and second induced magnetic anisotropies is oriented substantially parallel to a deposition plane of incidence.

18. A method as claimed in claim 12 wherein the nonzero deposition angle is chosen to supplement or oppose at least one of a shape anisotropy, a pair ordering anisotropy, and an intrinsic anisotropy of at least one of the first and second magnetic regions.

19. A method as claimed in claim 12 wherein the portion of the at least one of the first and second magnetic regions deposited at the nonzero deposition angle is a seed layer.

20. A method as claimed in claim 19 wherein the subsequent layers deposited on the seed layer are deposited at a substantially zero deposition angle relative to the reference line.

21. A method as claimed in claim 12 wherein the steps of depositing the first and second magnetic regions comprises using one of an ion beam deposition system and a physical vapor deposition system with a sputtering target wherein a substrate is swept over the sputtering target.

22. A method as claimed in claim 12 wherein each of the first and second magnetic regions is sandwiched between a first conductive line and a second conductive line.

23. A magnetoelectronic device comprising: at least one magnetic region having an induced magnetic anisotropy with a magnitude and a direction wherein the induced magnetic anisotropy is created by depositing at least a portion of the at least one magnetic region at a nonzero deposition angle relative to a reference line oriented substantially perpendicular to a surface of that region.

24. A magnetoelectronic device as claimed in claim 23 wherein the depositing of the at least one magnetic region comprises using one of an ion beam deposition system and a physical vapor deposition system with a sputtering target wherein a substrate is swept over the sputtering target.

25. A magnetoelectronic device as claimed in claim 23 wherein the at least one magnetic region includes an electrically insulating material layer sandwiched therebetween a first ferromagnetic layer and a second ferromagnetic layer and wherein the electrically insulating material layer forms a tunneling junction.

26. A magnetoelectronic device as claimed in claim 25 wherein the at least one magnetic region includes at least one layer of an anti-ferromagnetic coupling material.

27. A magnetoelectronic device as claimed in claim 26 wherein the portion of the at least one magnetic region deposited at the nonzero deposition angle is one of the first ferromagnetic layer, the second ferromagnetic layer, the electrically insulating material layer, the at least one layer of the anti-ferromagnetic coupling material, and combinations thereof.

28. A magnetoelectronic device as claimed in claim 23 wherein the nonzero deposition angle is chosen so that the direction of the induced magnetic anisotropy is oriented substantially perpendicular to a deposition plane of incidence.

29. A magnetoelectronic device as claimed in claim 23 wherein the nonzero deposition angle is chosen so that the direction of the induced magnetic anisotropy is oriented substantially parallel to a deposition plane of incidence.

30. A magnetoelectronic device as claimed in claim 23 wherein the portion of the at least one magnetic region deposited at the nonzero deposition angle is a seed layer deposited adjacent to at least one of the first and second conductive lines.

31. A magnetoelectronic device as claimed in claim 30 wherein the subsequent layers deposited on the seed layer are deposited at a substantially zero deposition angle relative to the reference line.

32. A magnetoelectronic device as claimed in claim 23 wherein the at least one magnetic region includes a fixed magnetic region.

33. A magnetoelectronic device as claimed in claim 23 wherein the at least one magnetic region includes a free magnetic region.

34. A magnetoresistive tunneling junction device with a switching field, comprising:

a substrate with a surface;

at least one magnetic region positioned on the substrate, the at least one magnetic region having an induced magnetic anisotropy with a magnitude and a direction; and

wherein the induced magnetic anisotropy is created by depositing at least a portion of the at least one magnetic region at a nonzero deposition angle relative to a reference line oriented substantially perpendicular to the surface of the substrate.

35. An apparatus as claimed in claim 34 wherein the at least one magnetic region is deposited using one of an ion beam deposition system and a physical vapor deposition system with a sputtering target wherein the substrate is swept over the sputtering target.

36. An apparatus as claimed in claim 34 wherein the at least one magnetic region includes an electrically insulating material layer sandwiched therebetween a first ferromagnetic layer and a second ferromagnetic layer wherein the electrically insulating material layer forms a tunneling junction.

37. An apparatus as claimed in claim 36 wherein the at least one magnetic region includes at least one layer of an anti-ferromagnetic coupling material.

38. An apparatus as claimed in claim 34 wherein the nonzero deposition angle is chosen so that a direction of the induced magnetic anisotropy is substantially perpendicular to a deposition plane of incidence.

39. An apparatus as claimed in claim 34 wherein the nonzero deposition angle is chosen so that a direction of the induced magnetic anisotropy is substantially parallel to a deposition plane of incidence.

40. An apparatus as claimed in claim 38 wherein the portion of the at least one magnetic region deposited at a nonzero deposition angle is a seed layer deposited adjacent to at least one of first and second conductive lines sandwiched around the at least one magnetic region.

41. An apparatus as claimed in claim 40 wherein the subsequent layers deposited on the seed layer are deposited at a substantially zero deposition angle relative to the reference line.

42. An apparatus as claimed in claim 34 wherein the magnetoresistive tunneling junction device includes a magnetoresistive random access memory device.

43. An apparatus as claimed in claim 38 wherein at least one of the first and second magnetic regions include a synthetic anti-ferromagnetic material layer that has an adjustable magnetic switching volume wherein the synthetic anti-ferromagnetic layer material includes N ferromagnetic layers which are anti-ferromagnetically coupled, where N is a whole number greater than or equal to two.

44. An apparatus as claimed in claim 34 wherein the nonzero deposition angle is chosen to obtain the switching field.

45. An apparatus as claimed in claim 43 wherein each N ferromagnetic layer is anti-ferromagnetically coupled by sandwiching a layer of an anti-ferromagnetic coupling material between each adjacent ferromagnetic layer.

46. An apparatus as claimed in claim 34 wherein the nonzero deposition angle is chosen to supplement or oppose at least one of a shape anisotropy, a pair ordering anisotropy, and an intrinsic anisotropy of at least one of the first and second magnetic regions.

47. A magnetoelectronic device as claimed in claim 34 wherein the at least one magnetic region includes a fixed magnetic region.

48. A magnetoelectronic device as claimed in claim 34 wherein the at least one magnetic region includes a free magnetic region.